# GPS System Performance Measurement and Analysis Overview

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# SPMA Introduction

GPS System Performance Measurement and Analysis (SPMA)

- Long-Term Archive of Key System Performance Parameters
- Mission Focused (Is GPS Doing Well or Poorly?)
  - Signal-in-Space PVT/Timing/NDS/Integrity
  - Provide Baseline to Compare GPS Evolutions Against
  - Could Provide Valuable Forecasting Tool
  - Comparison to Independent Data Sources (NIMA, IGS)
- Quarterly Web-Based Reports
  - 15 Section SPMA Report
    - Data from Multiple Agencies
    - Some Data Unique to this project
  - Spacecraft Quarterly Reports
  - Definition Document

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# SPMA Parameters

- **Signal In Space User Range Error (URE)**
  - As Broadcast
  - 1 Day Prediction
  - 14 Day Prediction
  - 60 Day Prediction (Unique)
  - Worst Case Prediction
- **GPS Timescale (Time Transfer)**
- **System Response Time (SRT)**
- **Estimated Range Deviation (ERD)**
- **Observed Range Deviation (ORD)**
- **Upload Count**

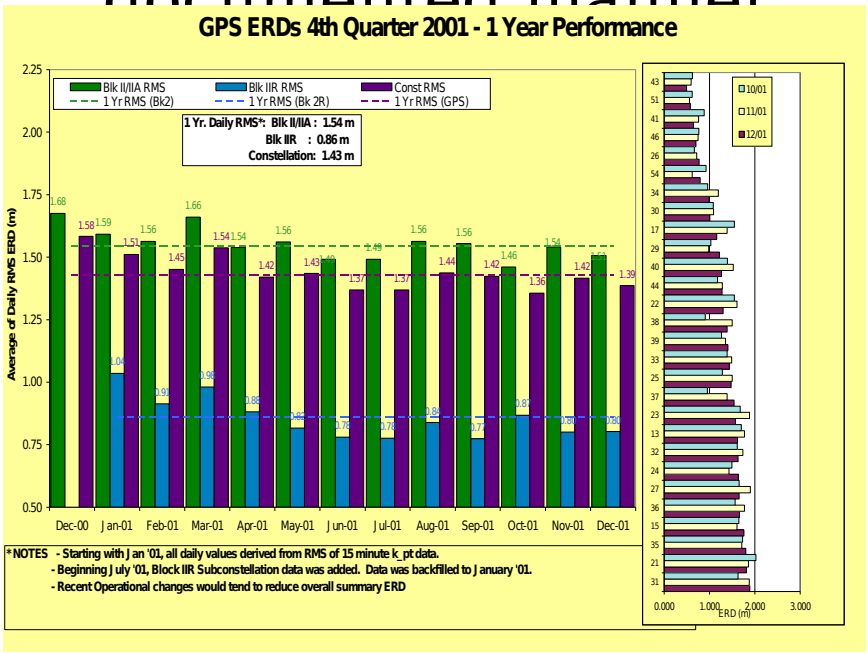
- **Measurement Residuals**
- **Position Dilution of Precision (PDOP)**
- **Earth Orientation Parameters**
- **Zero Age of Data URE (MCS as Truth Quality)**
- **Outages/Contact Summary**
- **Navigation Solution Deviation (NavSol)**
- **User Range Accuracy (URA)**
- **Events Summary**
- **Beta Angle**

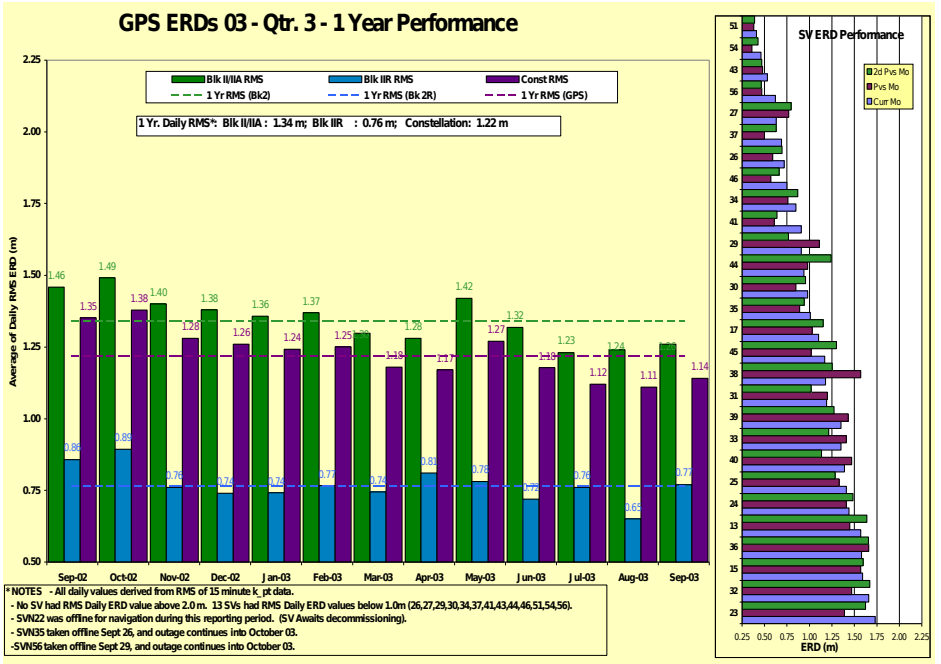
# Data Sources

- Data obtained from a variety of sources in the GPS community, including:
  - 2 SOPS
  - OCS
  - NIMA
  - NRL
  - IGS
  - 50th Communications Squadron

# SPMA Long-term Performance Archive

- Quarterly Reports Started in 4th Quarter 2001
- Provides a continuous data archive of parameters computed in a consistent and documented manner


GPS ERDs 4th Quarter 2001 - 1 Year Performance
Blk II/IIA RMS
Blk IIR RMS
Const RMS
1 Yr RMS (Bk2)
1 Yr RMS (Bk 2R)
1 Yr RMS (GPS)
1 Yr. Daily RMS*: Blk II/IIA : 1.54 m
Blk IIR : 0.86 m
Constellation: 1.43 m
Average of Daily RMS ERD (m)
Dec-00 Jan-01 Feb-01 Mar-01 Apr-01 May-01 Jun-01 Jul-01 Aug-01 Sep-01 Oct-01 Nov-01 Dec-01
10/01
11/01
12/01
ERD (m)
*NOTES - Starting with Jan '01, all daily values derived from RMS of 15 minute k_pt data.
- Beginning July '01, Block IIR Subconstellation data was added. Data was backfilled to January '01.
- Recent Operational changes would tend to reduce overall summary ERD


GPS ERDs 03 - Qtr. 3 - 1 Year Performance
Blk II/IIA RMS
Blk IIR RMS
Const RMS
1 Yr RMS (Bk2)
1 Yr RMS (Bk 2R)
1 Yr RMS (GPS)
1 Yr. Daily RMS*: Blk II/IIA : 1.34 m; Blk IIR : 0.76 m; Constellation: 1.22 m
Average of Daily RMS ERD (m)
Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 May-03 Jun-03 Jul-03 Aug-03 Sep-03
SV ERD Performance
2d Pvs Mo
Pvs Mo
Curr Mo
ERD (m)
*NOTES - All daily values derived from RMS of 15 minute k_pt data.
- No SV had RMS Daily ERD value above 2.0 m. 13 SVs had RMS Daily ERD values below 1.0m (26,27,29,30,34,37,41,43,44,46,51,54,56).
- SVN22 was offline for navigation during this reporting period. (SV Awaits decommissioning).
- SVN35 taken offline Sept 26, and outage continues into October 03.
-SVN56 taken offline Sept 29, and outage continues into October 03.

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# Sample Data

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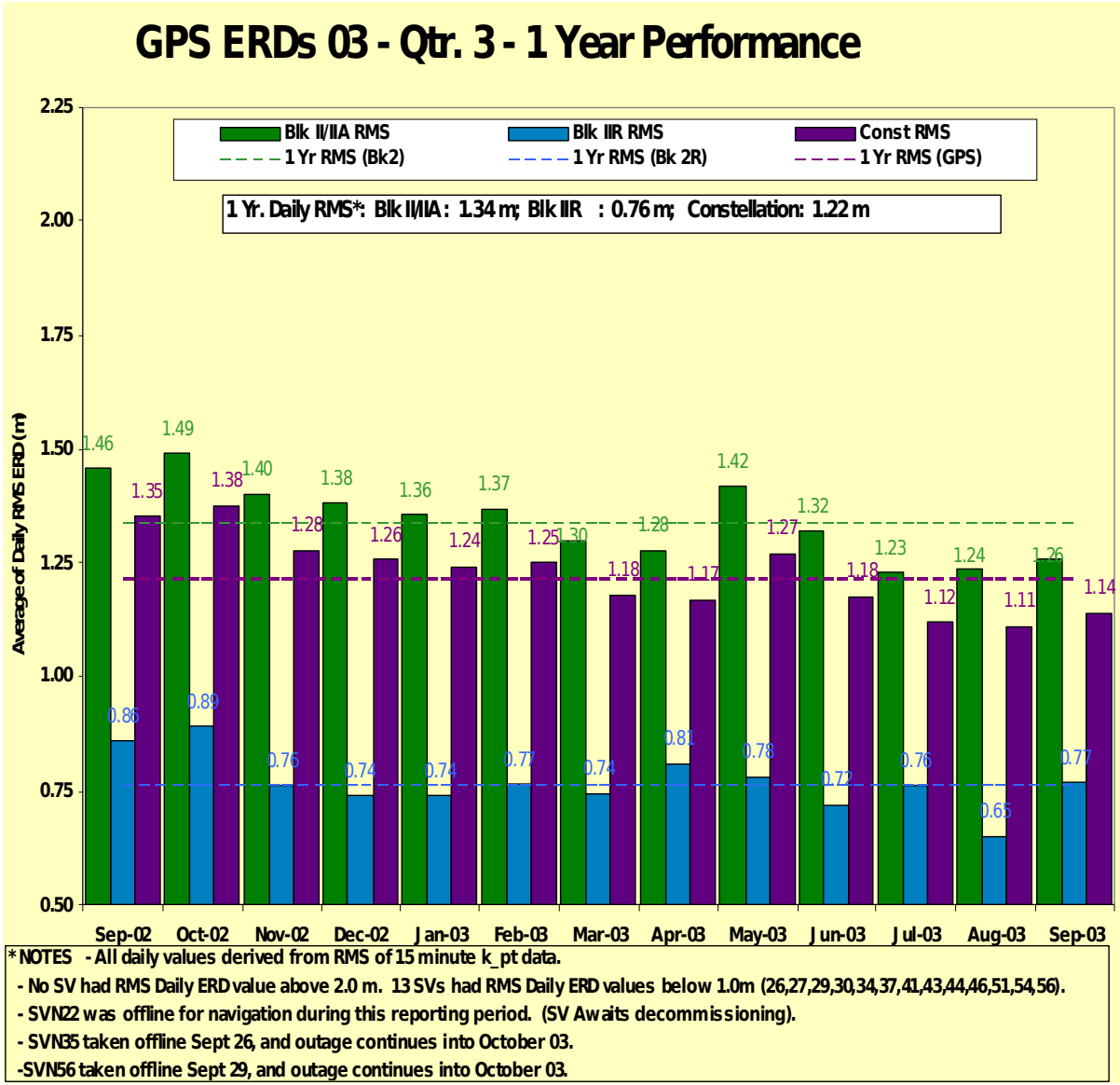
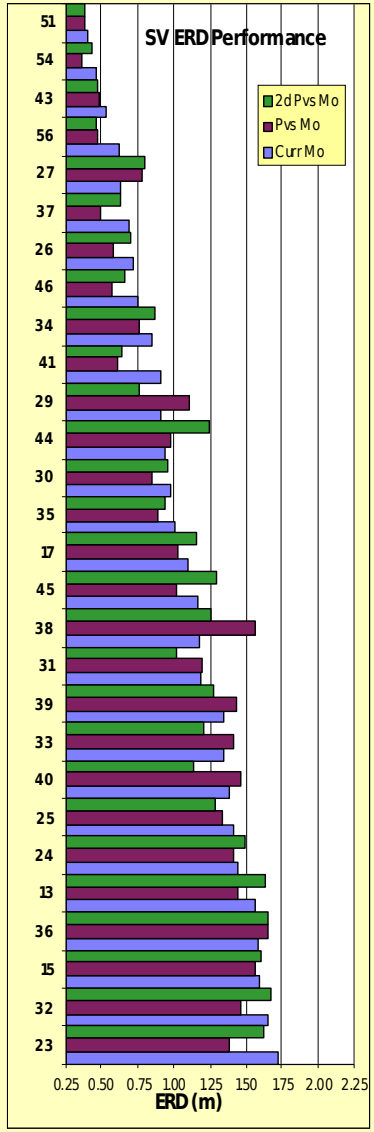
# ERD

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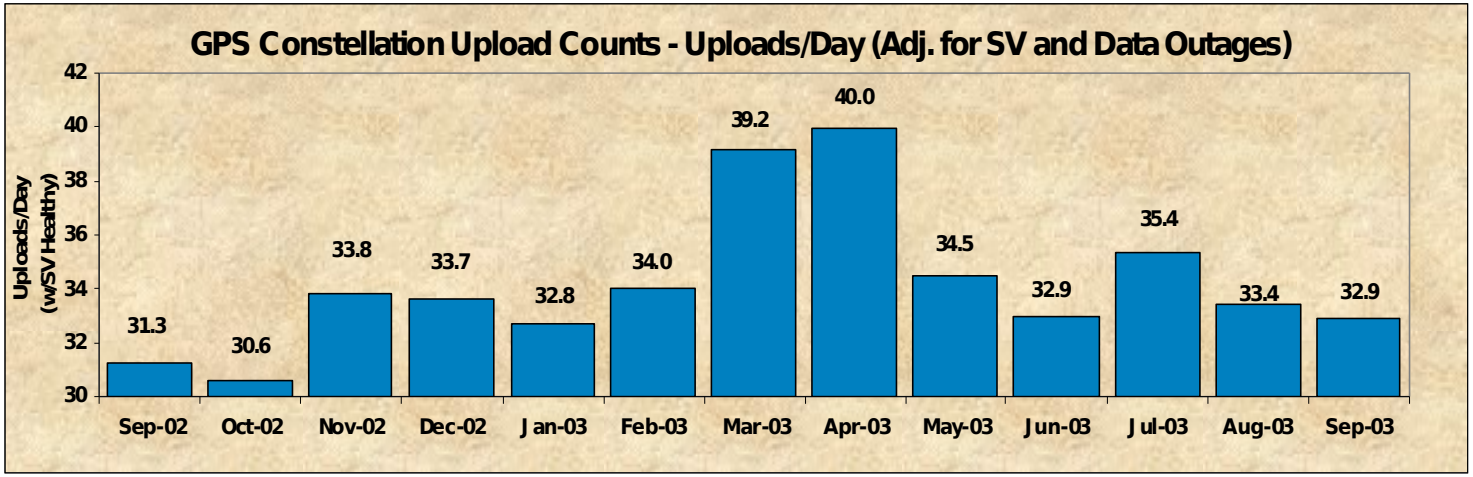
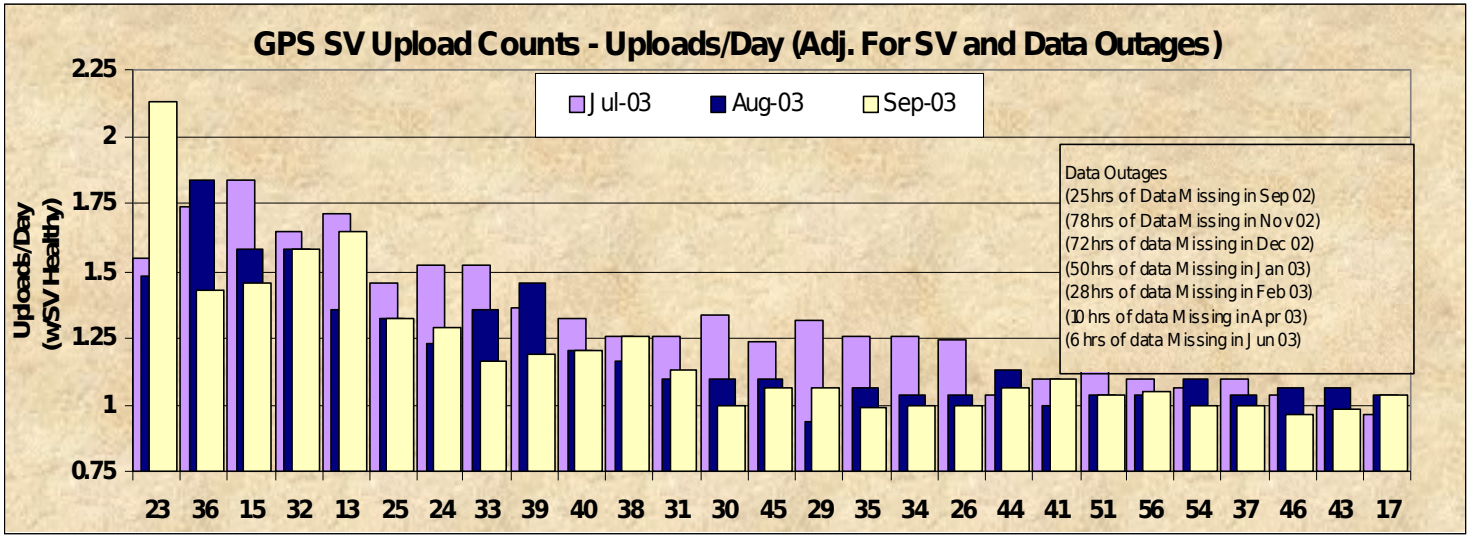
# Upload Count

## Quarterly Upload/Outage Summary for 3rd Quarter, 2003





GPS SV Upload Counts - Uploads/Day (Adj. For SV and Data Outages)
Uploads/Day (wSV Healthy)
2.25
2
1.75
1.5
1.25
1
0.75
Jul-03
Aug-03
Sep-03
Data Outages
(25 hrs of Data Missing in Sep 02)
(78 hrs of Data Missing in Nov 02)
(72 hrs of data Missing in Dec 02)
(50 hrs of data Missing in Jan 03)
(28 hrs of data Missing in Feb 03)
(10 hrs of data Missing in Apr 03)
(6 hrs of data Missing in Jun 03)
23 36 15 32 13 25 24 33 39 40 38 31 30 45 29 35 34 26 44 41 51 56 54 37 46 43 17

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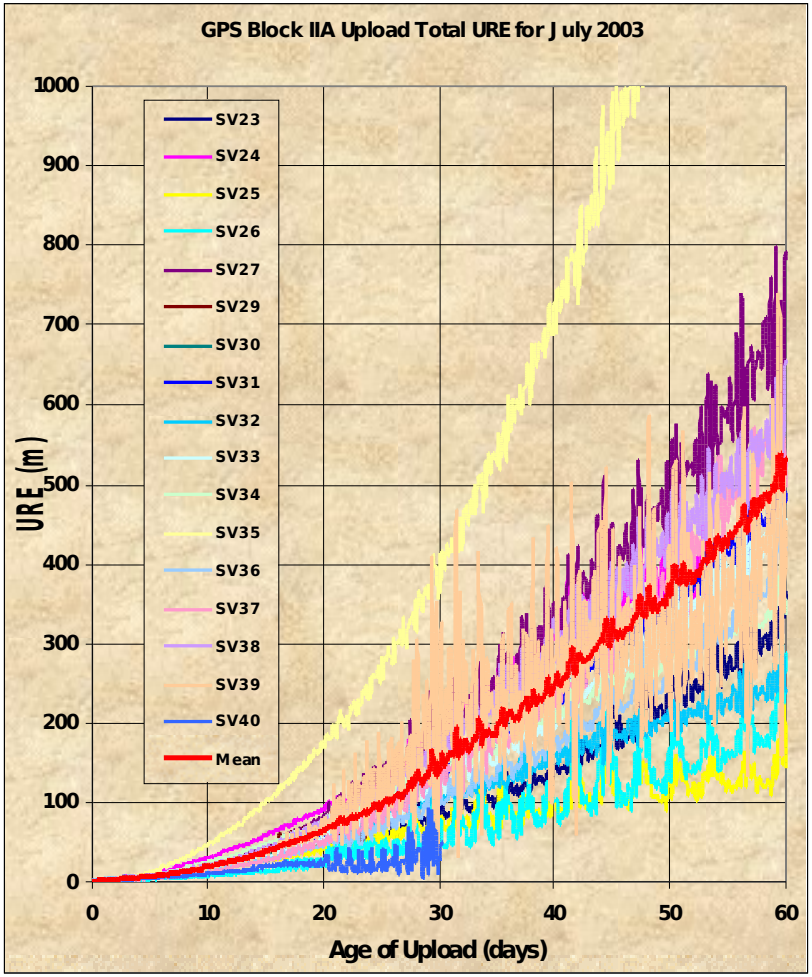
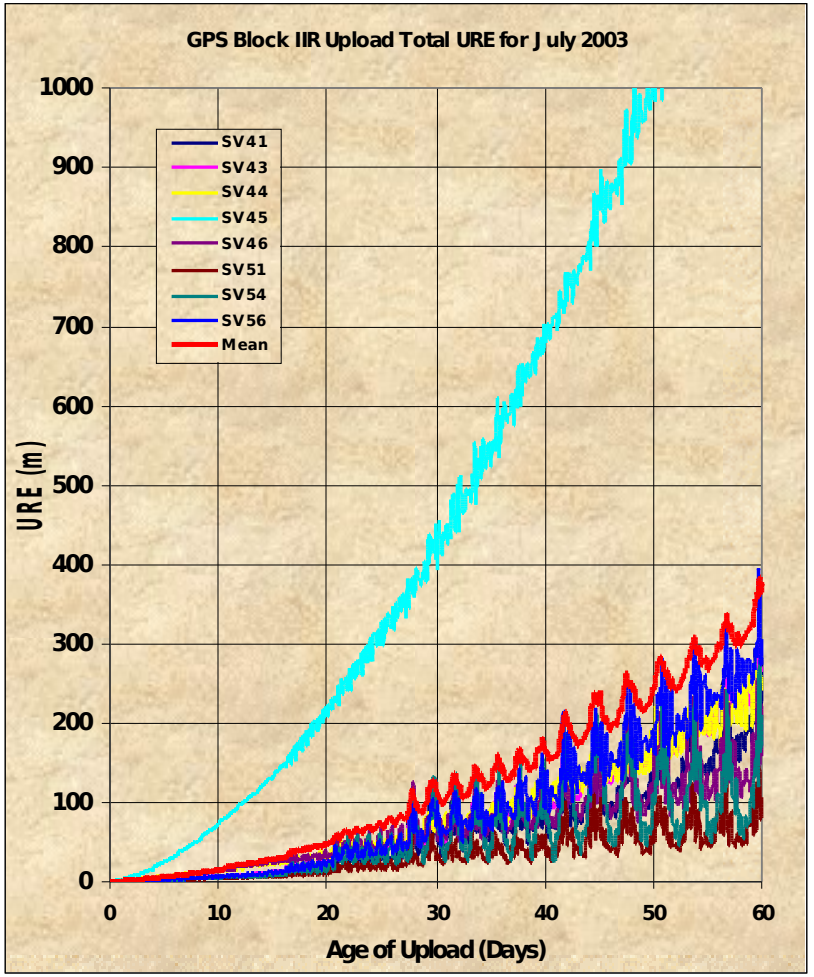
# 60 Day Total URE




**NOTES:**

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# SPMA Accomplishments

- **Initial draft of SPMA Task Order (Sep '00) focused on creating a system which would permit trend analysis to assess GPS System Evolution.**
- **SPMA Working Group Meeting 1 – August 2001**
  - **Community Analysis Experts Define SIS Performance Metrics List**
- **Y2001 Q4 (Report 1) - March 2002**
  - **Includes SPMA Definitions Document**
  - **Includes Block II/IIA and Block IIR Quarterly Reports**
- **GSIMS/SPMA Site Initialized – July 2002**
- **LM Subtask Addressing AEP Data Format/Transfer Completed – September 2002**
- **Quarterly Reports Produced for 2001 Q4 Through 2003 Q3**
  - **2003 Q4 Quarterly Report Production in Progress**

# SPMA Accomplishments (2)

- **Extended Performance metrics to include independent truth standards (NIMA, IGS, NRL)**
- **URE analysis supports verification of extended Nav Ops requirements**
  - **60 day accuracy requirement without navigation upload**
- **Insights into differences between AEP and Legacy data**
  - **Supports AEP shadow Ops Validation**
- **Database issue fixed as a result of SPMA report compilation**
- **Measurement Residual data Analysis has supported MSRE investigations**
- **Uncovered former data extraction deficiencies**
  - **Issue with earlier Zero Age of Data reporting discovered and corrected**
  - **MCS data issues beginning to surface (PRO cutover)**
- **SPMA permits trend analyses beyond AEP 24 Hr**

# Conclusion

- SPMA data available to the community through the GSIMS Website
  - Access www.gpssims.com
  - Click on the Download GSIMS User Request Form Button
  - Fill out the form requesting SPMA access and submit it